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Using tele-health to enhance motivation, leisure time physical activity, and quality of life in adults with spinal cord injury: A self-determination theory-based pilot randomized control trial☆

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ABSTRACT

Objectives: Novel and theory-based interventions promoting leisure time physical activity (LTPA) are needed for adults with spinal cord injury (SCI). The purpose of this study was to pilot test a tele-health intervention, grounded in self-determination theory, to enhance need satisfaction, motivation, physical activity, and quality of life among adults with SCI.

Design: Pilot randomized controlled trial.

Methods: Participants (N = 24) were randomized to either a control or intervention group (N = 22 completed the study). The intervention group received one, 1-h counselling session per week, for eight weeks and the sessions were delivered via an online video-chat platform. The counselling sessions focused on fostering the basic psychological needs and autonomous motivation, teaching behaviour change techniques, and self-regulatory strategies. The control group was asked to continue with their regular routine. Participants responded to a questionnaire at baseline, mid-, and post-intervention. Hedge's g effect sizes were used to examine group differences and reliable change indexes to verify individual changes.

Results: Compared to the control group, the intervention group reported greater autonomous motivation (Hedge's $g = 0.91$) and LTPA (Hedge's $g = 0.85$) post-intervention. Large to moderate effects supporting the intervention group were found for health participation at six weeks (Hedge's $g = 0.97$), and meaningful life experiences (Hedge's $g = 0.72$) and social cognitive predictors of LTPA (Hedge's $g > 0.76$) post-intervention.

Conclusion: This study demonstrated the preliminary effectiveness of a self-determination theory and tele-health LTPA counselling intervention for adults with SCI, which may help inform larger interventions aimed at promoting LTPA among this population.

Trial registration: ClinicalTrials.gov NCT02833935; https://clinicaltrials.gov/ct2/show/NCT02833935 (Archived by WebCite at http://www.webcitation.org/6u8U9x2yt)

1. Introduction

A spinal cord injury (SCI) is defined as any injury to the spinal cord that causes either temporary or permanent change in the spinal cord's normal function, resulting in complete or part loss of sensory and/or motor functions (American Spinal Injury Association and American Paralysis Association, 1996). Currently, an estimated 86,000 people live with SCI in Canada (Noonan et al., 2012). Leisure-time physical activity (LTPA; i.e., recreational physical activity done in one's free time) is a health-promoting behaviour that has been associated with physiological (i.e., increases in strength and endurance) and psychological (i.e., reductions in depressive symptoms and improvements in quality of life) benefits for adults with SCI (Daniel & Manigandan, 2005; Martin Ginis et al., 2010; Tomasone et al., 2013; Van der Scheer et al., 2017). To achieve these benefits, SCI-specific LTPA guidelines recommend at least 20 min of moderate to vigorous intensity aerobic

☆ A pilot SDT and tele-health physical activity intervention in SCI

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activity twice a week and strength training exercises two times per week (Martin Ginis et al., 2017). Unfortunately, a recent study in a Canadian sample found only 12% of adults with SCI are meeting the LTPA guidelines (Rocchi et al., 2017), and approximately 50% of adults with SCI report participating in 0 min of LTPA per week (Martin Ginis et al., 2010). Motivation, transportation, and accessibility are common barriers that impede in-person physical activity participation for adults with SCI (Cowan, Nash, & Anderson, 2013), highlighting the need to promote LTPA in adults with SCI.

A growing number of interventions promoting LTPA engagement for adults with SCI have been conducted (Best, Arbour-Nicitopoulos, & Sweet, 2017; Wilroy & Knowlden, 2016). Although several of these interventions were guided within theoretical frameworks such as the health action process approach (Schwarzer & Luszczynska, 2008), the results are inconsistent. Some interventions found significant increases in LTPA (e.g., Latimer, Martin Ginis, & Arbour-Nicitopoulos, 2006), while others did not (e.g., Arbour-Nicitopoulos, Tomasone, Latimer-Cheung, & Martin Ginis, 2014). These inconsistencies and the current lack of LTPA participation among the Canadian SCI population highlight a need to investigate other theoretical approaches to inform physical activity interventions, such as self-determination theory (SDT (Ryan & Deci, 2000);).

SDT is based on the assumption that humans have a tendency towards personal growth and well-being (Ryan & Deci, 2000). Accordingly, personal growth is achieved through 1) satisfying three main psychological needs of autonomy (i.e., volition in one's actions), competence (i.e., belief in one's actions) and relatedness (i.e., sense of belongingness), and 2) developing autonomous motivation (i.e., engaging in an activity because individuals value it and enjoy it) while reducing controlled motivation (i.e., engaging in activities due to external control and pressure). Achievement of these factors depends on the ability to create a social environment that fosters the basic psychological needs and autonomous motivation (Ryan & Deci, 2000).

SDT-based interventions have shown promise in promoting changes in autonomous motivation and LTPA in the general population (Fortier, Duda, Guerin, & Teixeira, 2012). Previous literature has identified a need to examine motivation on a broader scale. Past SCI interventions have focused on quantity of motivation (e.g., intentions), but lacked an examining of the quality of motivation (autonomous or controlled), which has unique predictive properties (Fortier et al., 2011). Further, SDT is unique compared to the other theories used in SCI physical activity interventions because it considers the social environment created by the physical activity counsellor. Despite these theoretical advantages, an SDT-based intervention to promote LTPA has yet to be conducted among adults with SCI. Within the SCI literature, a recent cross-sectional study (N = 73) found that autonomous motivation predicted the likelihood of meeting the LTPA guidelines (Rocchi et al., 2017). Similar findings have been found among individuals undergoing disability rehabilitation (Saebu, Sørensen, & Halvari, 2013). These studies show SDT's potential for promoting behaviour change in this population.

One approach that has aligned with SDT is motivational interviewing. Motivational interviewing is a client-centered counselling approach aimed to help participants explore their ambivalence and provoke behaviour change (Rollnick, Miller, Butler, & Aloia, 2009). Although motivational interviewing is not grounded in a theory, self-determination theory (SDT) has been proposed as a framework closely related to motivational interviewing because they share similar principles (Miller & Rollnick, 2012). For example, both motivational interviewing and SDT are based on the assumption that each individual has an innate tendency towards growth and well-being. Motivational interviewing allows for the social environment that is needed to support this tendency and promote behaviour change. Motivational interviewing has been used to promote LTPA behaviour change for adults with SCI (Arbour-Nicitopoulos et al., 2014; Tomasone, Arbour-Nicitopoulos, Latimer-Cheung, & Martin Ginis, 2018). Among adults with SCI, motivational interviewing interventions improved theoretical variables such as self-efficacy, perceived behavioural control, and intentions for LTPA (Arbour-Nicitopoulos et al., 2014; Latimer et al., 2006; Latimer-Cheung et al., 2013; Nooijen et al., 2016). None of these studies have combined MI and SDT principles to promote autonomous motivation and physical activity participation.

Traditionally, SDT-based LTPA interventions have been delivered primarily in-person (e.g., Fortier et al., 2012; Silva et al., 2008); however, for adults with SCI, accessibility and transportation are cited as a barrier to participation, and may limit access to in-person counselling (Vissers et al., 2008). As such, tele-health (i.e., the delivery of health education or health services through various tele-communication mediums; Phillips, Vesmarovich, Hauber, Wiggers, & Egner, 2001) may be an effective solution to this barrier. Some telephone-based interventions have successfully increased LTPA among adults with SCI (e.g., Latimer et al., 2006), while others have not found significant results (Arbour-Nicitopoulos et al., 2014). A tele-health delivery method that includes face-to-face interactions may be beneficial for promoting health behaviours (Nery, Driver, & Vanderbom, 2013).Video-based tele-health interventions could be a solution to delivering accessible face-to-face interventions. Video-based intervention delivery has been found to be a successful delivery method for health-related topics such as quality of life and pressure ulcers among adults with SCI (Martinez et al., 2017; Phillips et al., 2001). A recent SDT-based LTPA intervention in the general population found that an online tele-health approach can create an environment that supports the basic psychological needs (Friederichs, Oenema, Bolman, & Lechner, 2016). Therefore, combining a video-based intervention delivery modality with an interaction style grounded in SDT and motivational interviewing could be a successful approach to promote LTPA autonomous motivation and participation among adults with SCI.

The overall aim of the study was to pilot test an innovative eight-week video-based tele-health intervention framed within SDT to promote LTPA motivation, and participation in adults with SCI using a randomized controlled trial (RCT) study design. Results from this study will help determine if it will be feasible to expand this intervention to a full RCT. The *primary objective* was to examine the impact of the intervention on SDT-related variables at mid- and post-intervention among adults with SCI. Based on findings in the SDT literature (Fortier et al., 2012), we hypothesized moderately higher ratings in psychological need satisfaction and autonomous motivation, and moderately lower ratings in controlled motivation in the intervention group compared to the control group.

The *secondary objective* was to determine if the intervention group would report greater levels of LTPA and quality of life-related variables (life satisfaction, depressive symptoms, and participation in daily/social activities) in comparison to the control group. Based on previous research, we hypothesized that the intervention would have moderate and positive effects on LTPA (Latimer et al., 2006) and small-to-moderate positive effects on quality of life-related variables (Daniel & Manigandan, 2005), favoring the intervention group participants.

The *tertiary objective* was to explore group differences in key psychosocial variables in the exercise (e.g., action planning) and well-being (e.g., meaning) contexts, to gain a broader understanding of the possible impact of the intervention. For this exploratory purpose, we expected small to moderate differences between the intervention and control groups.

2. Methods

2.1. Participants

Based on previous literature (Arbour-Nicitopoulos et al., 2014), a purposive sampling method was used to recruit 24 adults with SCI between September 2016 and September 2017, with the trial completing in November 2017. With an expected 15% drop out rate, 20

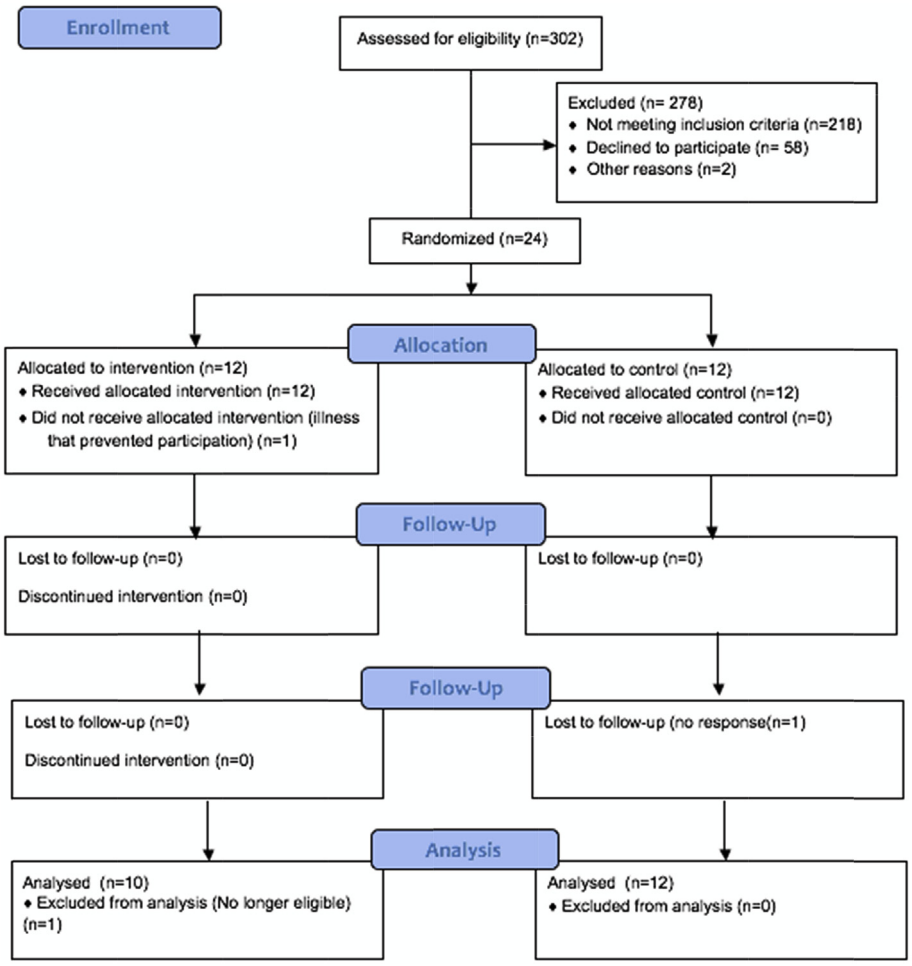

Fig. 1. Consort diagram. Flow diagram of the progress through the phases of a two group randomized control trial.

individuals were expected to complete the pilot RCT (Arbour-Nicitopoulos et al., 2014). Participants were recruited from outpatient rehabilitation hospitals in Montreal, a local adapted fitness center, an organisation representing persons with SCI, pre-existing databases of previous research participants, and social media platforms. A recent national comprehensive survey found approximately 67% of the Canadian SCI population are male (Noreau, Noonan, Cobb, Leblond, & Dumont, 2014). Thus, a representative sample was recruited with a goal of including 16 males and eight females (see Fig. 1 for the CONSORT flow chart). Eligible participants had to be over the age of 18 years; have paraplegia (i.e., an injury below the cervical segments of the spine that causes impairments or loss of motor and/or sensory function of the trunk, legs and/or pelvic organs; American Spinal Injury Association & American Paralysis Association, 1996); have sustained a SCI at least one-year prior to ensure sufficient time to adjust to living with SCI; be minimally active (engaging in less than two bouts of LTPA per week in the last two months, representing less than the minimum of LTPA guidelines; Martin Ginis et al., 2017); and be able to speak and understand English or French. To align with SDT, eligible participants had to be motivated for participating in LTPA, meaning they had the intention to become physically active in the next two months. This pilot RCT was limited to adults with paraplegia who use a mobility device to recruit a more homogeneous sample than if adults with any type or level of SCI were recruited. Additional inclusion criteria required participants to have access to a computer that meets the specific software requirements used in the intervention, and access to internet with adequate bandwidth (or a stable 3G cellular connection for wireless internet).

Participants were excluded if they were receiving in-patient rehabilitation services, reported concerns with memory or cognitive impairments, had severe communication or visual impairments, did not require a mobility device, or had answered yes to one of the questions on the SCI-inclusive physical activity readiness questionnaire (Bredin, Gledhill, Jamnik, & Warburton, 2013).

2.2. Procedures

Our protocol paper Sweet, Rocchi, Arbour-Nicitopoulos, Kairy, and Fillion (2017) contains a more detailed description of the study procedures. An 8-week intervention was chosen to align with results from an SCI LTPA promotion service (Get In Motion) which found that clients' physical activity had increased the most at 8 weeks and it was the point with the lowest drop-out rate (Arbour-Nicitopoulos et al., 2014). Ethical approval for the proposed project was obtained by the research ethics board of the Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal. Once participants provided informed consent, they completed a baseline questionnaire assessment online or over the telephone. Upon completion of the baseline questionnaire, participants were randomized and stratified by gender with blind, pre-labeled and randomly ordered envelopes. A two-week delay was implemented between completing the baseline questionnaire and beginning the intervention session to allow for set up of the tele-health software for the intervention group.

To reduce experimenter bias, a research assistant who was blinded to the participants' group allocation contacted each participant at six and 10 weeks post-baseline (i.e., four and eight weeks from the start of

intervention). Participants completed the questionnaires either by telephone or online. Each participant received a $30, $35 and $35 gift card for completing the baseline, six- and 10-week questionnaires, respectively.

2.3. Control group

The control group was asked to continue with their regular daily routine and were not encouraged to increase or decrease current physical activity levels. At the end of the study, control participants were contacted to schedule a 1-h session with the counsellor.

2.4. Intervention group

Participants in the intervention group were given instructions on how to download the Remote Education, Augmented Communication, Training and Supervision (REACTS®) online video-based software. Participants were trained on REACTS software, and had one brief introductory session with the LTPA counsellor (K.C.) to troubleshoot any remaining problems before the start of the intervention. Starting two weeks post-baseline, the LTPA counsellor conducted one LTPA counselling session per week for eight weeks, resulting in a total of eight counselling sessions.

The goal of the intervention was to motivate the participants to engage in LTPA in their home and/or within their community. The intervention was based on principles of SDT, and as such, the LTPA counsellor was responsible for fostering a LTPA counselling environment that was supportive of the basic psychological needs. This social environment was promoted through interpersonal counselling strategies derived from SDT and the spirit of motivational interviewing (e.g., empathizing, and acting in a warm and caring way). Furthermore, the counselling sessions aimed to foster LTPA motivation and participation through the use of behaviour change techniques and self-regulatory strategies (Michie et al., 2013). A toolbox of intervention components related to promoting satisfaction of the basic psychological needs was created as an intervention protocol to help structure the counselling sessions (please see Fig. 2 of our protocol paper Sweet et al., 2017). The inclusion of specific behaviour change techniques was chosen based on prior success in the literature. For example, action planning has been shown to be an effective behaviour change technique among adults with SCI (Latimer et al., 2006), and self-monitoring to be successful among adults with disabilities (Jaarsma & Smith, 2018).

The LTPA counsellor was a kinesiologist with training as a lifeguard and in youth and adult level coaching. Before recruitment began, the LTPA counsellor received training in behaviour change and in creating social environments to foster the basic psychological needs as per SDT from the co-authors (S.N.S and K.A.N). She also completed an exercise and health psychology graduate course, which covered SDT, and included a six-week behaviour change counselling assignment. She obtained level two motivational interviewing training certificate. She completed a two-day adapted physical activity training course with a local adapted physical activity organisation and completed the SCI−U course modules (http://www.sci-u.ca) to obtain further knowledge related to SCI. Finally, the LTPA counsellor received informal training with REACTS® from the creator of the software and a team member (B.F.). An implementation evaluation of this intervention was also conducted Rocchi et al. (2019).

2.5. Measures

2.5.1. Demographic information

Participants provided demographic information including age, gender, ethnicity, language, marital status, access to an adapted vehicle and accessible home, and income sources. Information specific to their SCI such as their cause of SCI, years since SCI, primary mode of mobility and access to transportation was also collected.

2.5.2. Primary outcomes: SDT variables

The validated Psychological Needs Satisfaction in Exercise Scale (Wilson, Rogers, Rodgers, & Wild, 2006) was used to assess perceived satisfaction of the basic psychological needs for LTPA (18 items). A total mean score was calculated for the autonomy, competence, and relatedness subscales. A total mean was calculated given the noted collinearity between the needs within the SDT literature (Milyavskaya & Koestner, 2011; Van den Broeck, Vansteenkiste, Hans De Witte, & Lens, 2008). In this study, a correlation greater than 0.50 was found between at least two needs within each time point (range: 0.56 to 0.74). A higher mean score indicated a greater perceived satisfaction of the basic psychological need. The Scale was found to be reliable as Cronbach's alphas were greater than 0.90 across the three time points.

The Treatment Self-Regulation Questionnaire (Levesque et al., 2007) was used to report motivation for LTPA. The subscale for autonomous motivation (six items) was found to be reliable as Cronbach's alphas were greater than 0.90 across all three time points. Internal reliability was found to be acceptable for controlled motivation (six items) at baseline and at six weeks, but low for 10 weeks post-baseline (see supplemental Table A).

2.5.3. Secondary outcomes: LTPA and QoL variables

The validated self-report seven-day Leisure-Time Physical Activity Questionnaire for adults with SCI was used to assess LTPA (Martin Ginis, Phang, Latimer, & Arbour-Nicitopoulos, 2012). Weekly minutes of moderate and vigorous strength training, and moderate and vigorous aerobic LTPA were added to calculate total moderate to vigorous LTPA (MVPA). Similarly, weekly minutes of mild, moderate, and vigorous strength training, and mild, moderate, and vigorous aerobic LTPA were summed to calculate total LTPA. The Life Satisfaction Questionnaire-11 (Fugl-Meyer, Melin, & Fugl-Meyer, 2002), and the Patient-Health Questionnaire-9 (Kroenke, Spitzer, & Williams, 2001) were used to self-report life satisfaction and depressive symptoms, respectively. The Patient-Perceived Participation in Daily Activities (Noreau et al., 2013) was used to assess participation in daily and social behaviours. All scales were found to be within the acceptable range for reliability as Cronbach's alphas were greater than 0.70.

2.5.4. Tertiary outcomes: Additional motivational and well-being variables

A series of questionnaire assessing social cognitive predictors of LTPA among adults with SCI (Martin Ginis et al., 2013) was used to assess self-efficacy, intentions, and action planning. The Meaning Questionnaire (Huta & Ryan, 2010) was used to measure meaningful life experiences. All scales were within the acceptable range for reliability as Cronbach's alphas were greater than 0.70. For more information on the measures, please see our protocol paper (Sweet et al., 2017).

2.6. Data analysis

2.6.1. Data cleaning/Preliminary analyses

All data were cleaned and screened for outliers, missing values, and distribution normality. Univariate outliers were examined by creating a standardized Z-score, where a Z-score greater than ± 3.29 was considered a univariate outlier (Tabachnick & Fidell, 2013). Univariate outlier scores were changed to one unit greater than the next largest score that was not an outlier. Next, missing data patterns were examined with Little MCAR's test (χ^2) to decide on data imputation method (Tabachnick & Fidell, 2013).

2.6.2. Analyses

Due to pilot nature of this intervention, several approaches were performed to provide a comprehensive examination of the data. First, Hedges' *g* effect sizes were computed, comparing the intervention to the control group at both six and 10 weeks for each variable. Data were entered into an effect size calculator to provide a Hedge's *g* with 95% confidence intervals. When large between group differences were

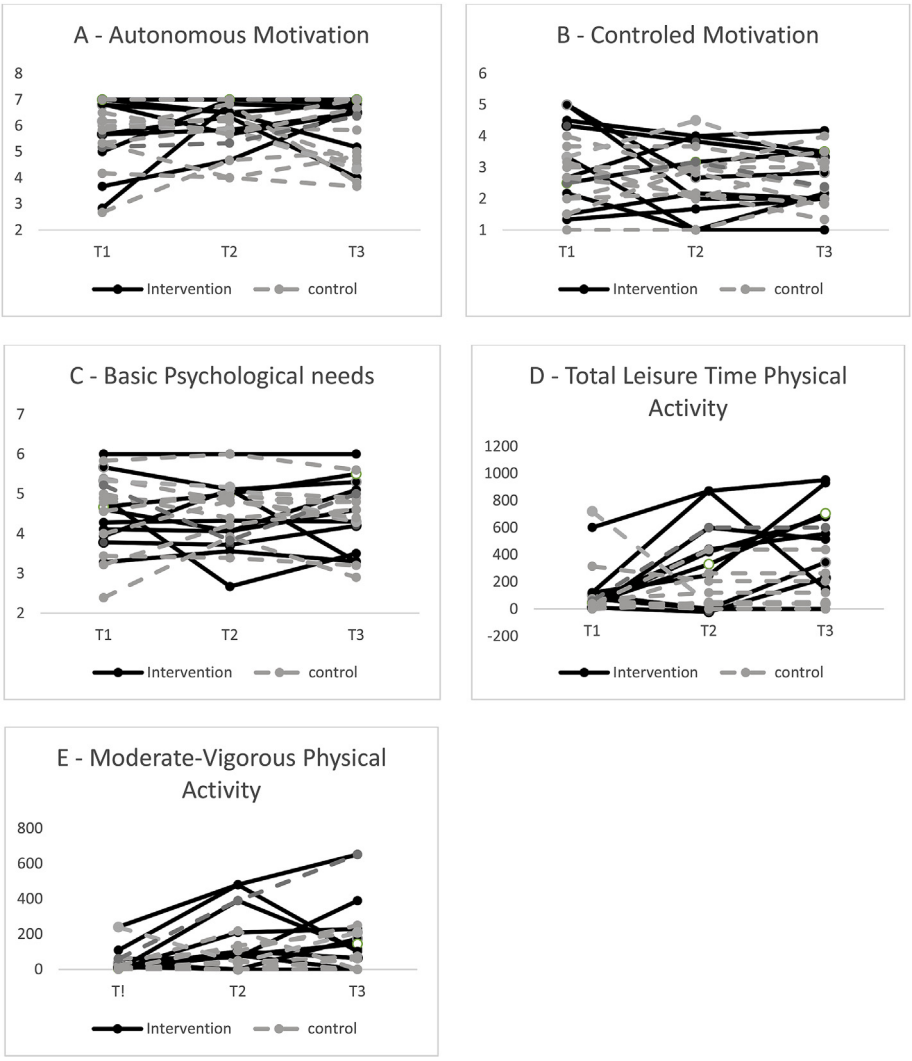

Fig. 2. Individual changes for primary outcomes and physical activity at baseline, 6 and 10 weeks.

found, a measure of effect size, d_{ppc}, for mean differences of groups with unequal sample size within a pre-post-control design (Morris, 2008) was calculated. All effect sizes were obtained using the calculator found on www.psychometrica.de/effect_size.html#cohenb. A Hedge's *g* of 0.2, 0.5 and 0.8 represented a small, moderate and large effect size, respectively (Lakens, 2013). These same cut points were used to interpret d_{ppc}.

Reliable change indices were calculated for the primary outcomes and LTPA. Using the means and standard deviations at baseline, 6, and 10 weeks, and the Cronbach's alpha at baseline, reliable change indices were estimates using an excel calculator (Retrieved from http://medhealth.leeds.ac.uk/info/2692/research/1826/research/2#pages). A reliable change index of ± 1.96 was considered a meaningful change over measurement error. Given that Cronbach's alphas cannot be calculated for the LTPA questionnaire, greater than 20 minutes increase of LTPA or MVPA (one bout of LTPA as per the SCI-specific LTPA guidelines for fitness benefits; Martin Ginis et al., 2017) was considered meaningful. The data from the primary and secondary outcomes were also graphed to visually represent individual change among participants in the control and intervention groups. To maintain transparency with the hierarchical multiple regressions originally proposed in our protocol paper, please see online supplemental material (Sweet et al., 2017).

3. Results

3.1. Preliminary analyses

Twenty-four adults with SCI were randomized into one of the two groups (see Fig. 1). Adjusting for participant dropout (see Fig. 1), 22 adults (N = 10 in the intervention group, N = 12 in the control group) were included in our analyses. Descriptive statistics suggested that between 0 and 3 observations were missing per variable; however, only 8 variables had more than 5% missing. Little MCAR's test was not significant (χ^2 = 175.99, DF = 649, p = 1.00), suggesting that the data were missing at least at random; as such, missing data were imputed using expectation maximization. A univariate outlier was found for one participant at all three time points for MVPA and at 10 weeks for total LTPA. The univariate outlier was replaced with the next closest value in range. Demographic and injury related information, and mean scores of each variable by group are shown in Tables 1 and 2, respectively.

3.2. Primary outcomes: SDT variables

3.2.1. Autonomous motivation

Compared to the control group ($M_{6\ weeks}$ = 5.63, SD_{6weeks} = 0.98; $M_{10\ weeks}$ = 5.31, $SD_{10weeks}$ = 1.21), the experimental group ($M_{6\ weeks}$ = 6.33, SD_{6weeks} = 0.75; $M_{10\ weeks}$ = 6.32, $SD_{10weeks}$ = 0.97) reported greater autonomous motivation at six weeks (Hedges' g = 0.79),

Table 1
Demographic information.

Variable	n (%)	*M*	SD
Age (in years), *M* (s.d.)		51.64	12.13
Sex (% male)	16 (72.7)		
Geographical location (% Canadian)	19 (86.4)		
Language (% English speaking)	9 (40.9)		
Ethnicity (% white)	21 (95.5)		
Years since SCI, *M* (s.d.)		15.45	12.85
Mobility mode			
Manual wheelchair	16 (72.7)		
Power wheelchair	3 (13.64)		
Walking with assistive device	3 (13.64)		
Cause of SCI (% accidental trauma)	13 (59.1)		
% with paid employment	7 (31.8)		
% with access to an adapted vehicle	14 (63.6)		
% with adapted home	17 (77.3)		
% married or common law	16 (72.7)		

Note. Abbreviations: SCI = spinal cord injury. *M* = mean. SD = Standard deviation. Geographical location = Canada, United States of America; Cause of SCI = accidental trauma, non-trauma acquired

and at 10 weeks (Hedges' $g = 0.91$) as represented by the moderate-to-large and large effect sizes (see Table 2). From baseline, the change in autonomous motivation in the intervention group was small at six ($d_{ppc} = 0.34$) and moderate at 10 ($d_{ppc} = 0.57$) weeks compared to the control group. A visual inspection of Fig. 2 (Panel A) appears to show more individuals in the intervention group reporting higher autonomous motivation at 10 weeks. According to the reliable change index calculation, 20% (2/10) and 30% (3/10) of intervention group participants increased their autonomous motivation at six and 10 weeks, respectively. At both time points, 17% (2/12) of control group participants reliably increased their autonomous motivation. No participant and 20% (2/10) of participants in the intervention group reliably decreased their autonomous motivation at six and 10 weeks, respectively. In contrast, 8% (1/12) and 42% (5/12) of control group participants decreased their autonomous motivation across those same time points (see Fig. 2A).

3.2.2. Controlled motivation

Small effect sizes were found at six (Hedges' $g = -0.24$), and very small effect sizes were found at 10 weeks (Hedges' $g = 0.02$; see Table 2) for controlled motivation when comparing the intervention and control groups. From baseline to six weeks, 30% (3/10) of participants in the intervention group reliably decreased their controlled motivation compared to 8% (1/12) of control group participants. From baseline to 10 weeks, 20% (2/10) of participants in the intervention group reliably decreased their controlled motivation, compared one (8%) who increased and another (8%) who decreased in the control group (see Fig. 2B).

3.2.3. Basic psychological needs

A small, negative effect size was estimated at six (Hedges' $g = -0.30$), and a very small effect size was estimated at 10 weeks (Hedges' $g = 0.10$) for perceived basic psychological needs satisfaction when comparing the intervention to the control groups (see Table 2). Additional exploratory post-hoc analyses for each individual basic psychological need was conducted given they have been found to play different roles for physical activity adoption and adherence (Kinnafick, Thøgersen-Ntoumani, & Duda, 2014). Moderate effect sizes were found for competence at 10 weeks (Hedge's $g = 0.45$), and relatedness at six weeks (Hedge's $g = 0.50$). From baseline to six weeks, one (10%) participant in the intervention group reliably increased, and one decreased his/her rating of basic psychological needs satisfaction compared to 25% (3/12) who increased and 8% (1/12) who decreased in the control group. From baseline to 10 weeks, one participant in each group reliably increased and two in each group reliably decreased their ratings in basic psychological need satisfaction (see Fig. 2C). See Supplemental Tables C and D for the hierarchical multiple regression analyses of the primary outcomes.

3.3. Secondary outcomes: LTPA and quality of life variables

3.3.1. LTPA

Compared to the control group ($M_{6\ weeks} = 149.30$, $SD_{6weeks} = 194.75$; $M_{10\ weeks} = 253.36$, $SD_{10weeks} = 272.15$), the intervention group ($M_{6\ weeks} = 375.82$, $SD_{6weeks} = 334.12$; $M_{10\ weeks} = 505.82$, $SD_{10weeks} = 322.84$) reported greater total minutes of LTPA at six weeks (Hedges' $g = 0.87$), and 10 weeks (Hedges' $g = 0.85$; Table 2). In addition, the change in total minutes of LTPA from baseline was very large at six ($d_{ppc} = 1.14$) and 10 ($d_{ppc} = 1.28$) weeks in the intervention group compared to the control group. From baseline to six weeks, 70% (7/10) of participants in the intervention group, compared to 50% (6/12) participants in the control group increased their total levels of LTPA by more than 20 min. From baseline to 10 weeks, 90%

Table 2
Mean, standard deviations, and effect sizes for primary and secondary outcomes at baseline, six, and 10 weeks.

Variable	Baseline				Six weeks				Ten weeks			
	Intervention		Control		Intervention		Control		Intervention		Control	
	M	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD
AM	5.75	1.50	5.51	1.15	6.33	0.75	5.63	0.98	6.32	0.97	5.31	1.21
Hedge's g (95% CI)					.79 (−.08, 1.66)				*.91 (.03, 1.79)*			
CM	3.23	1.40	2.63	0.89	2.55	1.17	2.79	0.88	2.65	0.97	2.63	0.80
Hedge's g (95% CI)					-.24 (−1.08, 0.61)				.02 (−.82, .86)			
BSN	4.52	0.84	4.50	1.03	4.36	0.96	4.61	.70	4.51	.96	4.43	.74
Hedge's g (95% CI)					-.30 (−1.15, .54)				.10 (−.75, .93)			
Total LTPA	116.70	175.54	114.17	208.82	375.82	334.12	149.30	194.75	505.82	322.84	253.36	272.15
Hedge's g (95% CI)					*.87 (-.01, 1.75)*				*.85 (-.02, 1.73)*			
MVPA	47.50	76.43	32.92	69.03	168.72	211.22	81.54	118.68	187.44	199.55	121.35	192.42
Hedge's g (95% CI)					.52 (−.33, 1.38)				.34 (−.51, 1.18)			
Life satisfaction	4.41	0.76	4.31	0.92	4.42	0.75	4.17	0.95	4.64	0.70	4.23	0.89
Hedge's g (95% CI)					.29 (−.56, 1.13)				.51 (−.35, 1.36)			
Depressive Sym	0.50	0.44	0.56	0.62	0.56	0.41	0.68	0.66	0.63	0.44	0.56	0.62
Hedge's g (95% CI)					-.21 (−1.06; .63)				.13 (−.71; .97)			
Health Part	4.3	1.06	4.5	1.17	5.2	0.92	4.09	1.3	5.1	0.99	4.09	3.02
Hedge's g (95% CI)					*.97 (.08, 1.86)*				.43 (−.42; 1.28)			

Note. Abbreviations: *M* = Mean. SD = Standard deviation. BSN = Basic psychological needs. LTPA = Leisure time physical activity. MVPA = Moderate and vigorous LTPA. CM = controlled motivation. AM = autonomous motivation. Sym = symptoms. Part = participation.

(9/10) of participants in the intervention group, and 50% (6/12) of participants in the control group increased their total levels of LTPA by more than 20 min (Fig. 2D).

3.3.2. MVPA

For MVPA, moderate effect sizes were found at six weeks (Hedges' $g = 0.52$), and small effect sizes were found at 10 weeks (Hedges' $g = 0.34$) favoring the intervention group ($M_{6\ weeks} = 168.72$, $SD_{6weeks} = 221.22$) over the control group ($M_{6\ weeks} = 81.54$, $SD_{6weeks} = 118.68$; see Table 2). From baseline to six weeks, 70% (7/10) of participants in the intervention group compared to 50% (6/12) of participants in the control group increased their MVPA by more than 20 min. From baseline to 10 weeks, 70% (7/10) of participants in the intervention group and 42% (5/12) of participants in the control group increased their total levels of MVPA by more than 20 min (see Fig. 2E).

3.3.3. Life satisfaction, depressive symptoms and participation

For life satisfaction, the intervention group ($M_{10\ weeks} = 4.64$, $SD_{10weeks} = 0.70$) reported slightly greater levels at six weeks (Hedges' $g = 0.29$), and moderately greater levels at 10 weeks (Hedges' $g = 0.51$; Table 2) compared to the control group ($M_{10\ weeks} = 4.23$, $SD_{10weeks} = 0.89$). Similarly, small to very small effect sizes were found on perceived depressive symptoms compared to the control group at six (Hedges' $g = -0.21$), and 10 weeks (Hedges' $g = 0.13$; see Table 2). Effect size calculations for participation in health behaviours found that the intervention group ($M_{6\ weeks} = 5.2$, $SD_{6weeks} = 0.92$) reported a large increase at six weeks (Hedges' $g = 0.97$), and a small increase at 10 weeks (Hedges' $g = 0.43$) compared to the control group ($M_{6\ weeks} = 4.09$, $SD_{6weeks} = 1.3$; see Table 2). Due to the large effect at six weeks, we examined the change from baseline and found large changes ($d_{ppc} = 1.22$) in the intervention group compared to the control group. See Supplemental Tables E − H for the hierarchical multiple regressions for the secondary outcomes.

3.4. Tertiary outcomes

Moderate to large effects were found for a number of tertiary outcomes favoring the intervention over the control group (see Table 3 for all effect sizes). Specifically, the intervention group reported greater levels of meaningful life experiences at 10 weeks, barrier and task self-efficacy at 10 weeks, and action planning at six and 10 weeks. Following up on the large effects for barrier self-efficacy at 10 weeks, it was found that the change in barrier self-efficacy from baseline was small ($d_{ppc} = 0.31$) in the intervention group compared to the control group. See Supplemental Tables I - M for the hierarchical multiple regressions of tertiary outcomes.

4. Discussion

The purpose of this pilot RCT was to provide preliminary results to determine whether individuals who received this SDT and video-based intervention reported greater levels in SDT-based variables (primary objective), LTPA and quality of life-related variables (secondary objective), and psychological variables (tertiary objective) compared to individuals in the control group. Compared to the control group, intervention participants had greater autonomous motivation and LTPA from baseline to post-intervention as represented by large effect sizes. Moderate effects at post-intervention were also found for life satisfaction, meaningful life experience, and large effects were found for health participation at six weeks. This pilot RCT provided much needed pilot data to demonstrate the preliminary effectiveness of an 8-week SDT and tele-health based intervention to promote LTPA among adults with SCI.

Results from the current pilot study suggest that an SDT-based behavioural intervention may, at least in the short term, increase and limit decreases in autonomous motivation for LTPA in adults with SCI. In addition to finding large sized mean-based effects, the reliable change indices provided deeper insight into the impact of our intervention. It appears that our SDT-based intervention helped individuals maintain their autonomous motivation over 10 weeks given that a larger proportion of individuals in the control group (42%) decreased their autonomous motivation in comparison to the intervention group (20%). These results are similar to those of the Latimer et al. (2006) intervention where participants in the intervention group had sustained motivation for LTPA. Motivation has been found to be one of the most prevalent perceived barriers among adults with SCI, leading to recommendations for interventions to promote and maintain internal/autonomous motivation (Cowan et al., 2013). A larger, and longer SDT-based intervention among adults with SCI could closely look at the effects and trends of autonomous motivation over the long term.

In contrast to our hypotheses, small to no group effects and no individual differences between groups were found for controlled motivation. Few SDT-based interventions have looked at changes in controlled motivation, but our results appear to be similar to the available literature. For instance, a 12-month behaviour change intervention for overweight women similarly found that compared to the control group, their intervention group was associated with only small decreases in controlled motivation (Silva et al., 2008). Whereas another intervention with female university students found no intervention effects for changes in controlled motivation (Edmunds, Ntoumanis, & Duda, 2008). Future research should measure and report controlled motivation to help better examine the impact of SDT interventions. In addition, measuring this variable could help understand how controlled and autonomous motivation may coexist along side each other (Thøgersen-Ntoumani & Ntoumanis, 2006) to influence LTPA behaviour change.

Table 3
Mean, standard deviations, and effect sizes for tertiary outcomes at baseline, six, and 10 weeks.

Variable	Baseline				Six weeks				Ten weeks			
	Intervention		Control		Intervention		Control		Intervention		Control	
	M	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD
Meaning	5.40	1.53	5.11	1.42	5.30	0.87	5.02	1.08	5.50	0.95	4.78	1.03
Hedge's g (95% CI)					.18 (−.66; 1.02)				.72 (−.14, 1.59)			
Intentions	4.70	2.2	4.58	1.96	5.50	1.16	4.66	1.84	5.05	2.43	4.33	1.37
Hedge's g (95% CI)					.54 (−.32, 1.39)				.38 (−.47, 1.22)			
Barrier SE	5.42	1.36	4.65	1.57	5.00	1.60	3.98	1.47	5.17	1.14	3.94	1.20
Hedge's g (95% CI)					.67 (−.20, 1.53)				1.05 (.15, 1.94)			
Task SE	5.05	1.55	4.65	1.85	4.48	1.93	4.12	1.21	5.11	1.31	3.97	1.77
Hedge's g (95% CI)					.23 (−.61, 1.07)				.74 (−.13, 1.61)			
Action planning	5.4	1.36	4.48	1.62	5.45	1.81	4.02	2.16	5.45	1.31	4.10	2.07
Hedge's g (95% CI)					.71 (−.15, 1.58)				.76 (−.11, 1.63)			

Note. SE = self-efficacy

The small effects found in the current study for perceived satisfaction of the basic psychological needs were contrary to our hypotheses, consistent with some studies, but not others (Edmunds et al., 2008; Silva et al., 2008). The exploratory post-hoc analyses for each individual psychological need found moderate effect sizes for competence at 10 weeks, and relatedness at six weeks. Interestingly, the relatedness items in the Psychological Needs Satisfaction in Exercise Scale (Wilson et al., 2006) assess sense of connection between people who exercise together, but our intervention did not place a particular importance on engaging in LTPA with others. However, social support was often discussed, which may have encouraged intervention participants to exercise with another person or in a group. It is possible that the interactions the participants had with an exercise companion or a group helped support their need for relatedness. Unfortunately, we do not have the data to explore whether social support was the trigger for moderately greater ratings of relatedness in the intervention group compared to the control group.

The moderate effects of competence tie in with the moderate and large effects we found for task and barrier self-efficacy supporting the intervention group over the control group. These effects reflect the results from other LTPA interventions among adults with SCI (e.g., Latimer et al., 2006). In fact, self-efficacy/competence variables appear to be relatively consistent outcomes in SCI LTPA interventions (Wilroy & Knowlden, 2016). As such, this pilot study may support these findings, and may expand on the current LTPA interventions in SCI by exploring motivational variables, such as autonomous motivation, to promote LTPA participation.

Despite the short duration of our SDT-based intervention, we found large effects for total LTPA, and small to moderate group effects for MVPA at six weeks, and 10 weeks. The overwhelming majority (90%) of intervention participants increased their total LTPA by at least 20 min at 10 weeks, while only half of the control group demonstrated a similar increase in their LTPA participation. Light intensity LTPA appeared to be important in this study given larger effects were found for total LTPA than MVPA. Although light LTPA may not bring the fitness or cardiovascular health benefits of MVPA as per the LTPA guidelines for SCI (Martin Ginis et al., 2017), light LTPA might be an important stepping stone to behaviour change. Among beginners and those who are the least physically fit, low intensity LTPA may still provide large health benefits while reducing health risks (Durstine et al., 2000). Future interventions should monitor how beginner exercisers living with SCI gradually progress in their LTPA participation in terms of frequency, duration, and intensity of LTPA.

Moderate and large effects were found for health participation at six weeks, and life satisfaction and meaningful life experiences at 10 weeks, while small effects were found for other variables such as depressive symptoms. Factors beyond physical activity, such as pain and secondary complications (Tulsky et al., 2015), or the short length of the intervention may explain why we found small effects for these other quality of life-related variables. In a 6-month behavioural LTPA intervention, Nooijen et al. (2017) did not find effects on quality of life variables, despite seeing changes in cardiometabolic measures among adults with SCI. However, they did find significant differences in participation between the intervention and control groups at six and 12 months post-intervention. We may observe greater effects in these broader outcomes if the participants were followed post-intervention.

4.1. Theoretical implications and practical applications

This pilot RCT preliminarily demonstrated that a need supportive LTPA counselling environment may enhance autonomous motivation and LTPA among adults with SCI. As a result, it lends support to SDT's tenets and begins to extend the generalizability of SDT to the SCI population. These results can then inform the adaptation of a larger RCT. Before conducting such a trial, it may be important to explore the role of the individual basic psychological needs in the promotion of LTPA in adults with SCI given our unexpected findings. This exploration could closely examine the measurement of the psychological needs in an LTPA setting and how the current items align with the experiences of adults with SCI during and after an intervention.

It may also be beneficial to consider other explanations, beyond SDT, as to why our intervention did not result in changes in the basic psychological needs. The therapeutic alliance, defined as the connection created by the counsellor though the use of interpersonal strategies such as care and empathy, could provide an explanation. It has been proposed that therapeutic alliance alone may foster behaviour change independently from the theories and techniques used in counselling sessions (Duncan, Miller, Wampold, & Hubble, 2010). As such, the therapeutic alliance could explain why some of the basic assumptions of SDT did not hold. As such, therapeutic alliance should be explored in future LTPA promotion research in adults with SCI.

Results from this pilot study begin to suggest that a need supportive social environment can be created through a video-based tele-health LTPA intervention for people with SCI. Additionally, through the use of video-based technology, the current study was able to effectively extend research and services beyond traditional university and rehabilitation settings, and interventions using the telephone (Best et al., 2017). Future practical applications may include the use of this technology in community-based organizations to provide face-to-face interventions to help reduce barriers related to transportation and accessibility.

4.2. Limitations and future research

Despite the theoretical and practical implications, our study is not without limitations. Given the pilot nature of this study, sample size is small, and the intervention was only conducted over eight weeks. As autonomous motivational may be considered unstable after 6 months (Rodgers, Hall, Duncan, Pearson, & Milne, 2010), future interventions should be longer in duration, and include follow-up time points to determine if the effects are sustained post-intervention (Best et al., 2017). Other designs could have been implemented to test our hypotheses, such as a self-controlled, multiple baseline intervention.

Self-reported measures for LTPA may have led to overestimation of LTPA levels. This overestimation appears to be the case for participants in this study as there were discrepancies between what was reported at the time of screening and what was reported at baseline. Future intervention studies may benefit from using more objective measures (i.e., accelerometers, Nooijen et al., 2016; McCracken et al., 2018), along with self-reported outcomes, to capture the impact of the intervention on LTPA outcomes. Additionally, the measure for the basic psychological needs only examined perceived need satisfaction. Future interventions should also examine the dimension of basic psychological need frustration (Ryan & Deci, 2000). Moreover, the calculated reliability of controlled motivation measure was low, thus those results should be interpreted with caution.

Despite the technological innovation used in this study, participants needed to be familiar with using technology and have access to a computer, limiting the accessibility of this design to all members of the SCI community. Future research should also explore the effects of the intervention on all levels of SCI and levels of motivation, as the current study was limited to adults with paraplegia and those who were not amotivated for LTPA.

5. Conclusion

Our 8-week pilot RCT used SDT as a guiding framework, and a video-based tele-health modality to provide LTPA counselling to adults with SCI. Results found a preliminary indication of the effectiveness of this intervention to promote autonomous motivation and LTPA in this population. These preliminary results add to the current literature as it gives insight into the motivational factors linked to LTPA among adults

with SCI. Being the first video-based tele-health intervention to promote LTPA in this population, this research highlighted the feasibility of video-based technology and will help inform the basis of future larger and longer-term interventions aimed to promote LTPA in adults with SCI.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.psychsport.2019.03.008.

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